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Post-Pleistocene Raccoons from Central Texas and their Zoogeographic Significance

by

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Director

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Post-Pleistocene Raccoons from Central Texas and Their Zoogeographic Significance

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INTRODUCTION

Remains of the raccoon *Procyon lotor* are common in late Pleistocene and post-Pleistocene deposits. Several localities in Central Texas have yielded remains of a *Procyon* characterized by a more massive skull and mandible than the extant *Procyon lotor fuscipes* population of this area. This material is similar to that described by Gidley (1906) as *Procyon simus*. These specimens represent the first occurrence of heavily built raccoons from Central Texas and therefore are a considerable range extension. Three of the Central Texas finds have been dated by carbon 14, giving some indication of the time of replacement of the heavily built type by the less massive, modern type.

The material discussed here came from the Levi Shelter in Travis County, the Kyle Site in Hill County, the Wunderlich Site in Comal County, and Longhorn Cavern in Burnet County. The Kyle Site has been described by Jelks (1962), and the paleontology and stratigraphy of Longhorn Cavern has been described by Semken (1961). In addition, *Procyon* sp. material of modern type has been discovered from the following archeological sites: Manton Miller Site in Delta County, Whelan Site in Marion County, and Buzzard Cave in Hill County.

These fossil and sub-fossil specimens have been compared to a sample of thirty-seven specimens of *Procyon lotor fuscipes* from Central Texas, a sample of thirteen specimens of *Procyon lotor hirtus* from Wisconsin, and a sample of seven specimens of *Procyon lotor excelsus* from Idaho and Oregon. The comparison of the type of *Procyon simus* Gidley and the sample of *Procyon lotor excelsus* Nelson and Goldman show that they are referable to the same species. Since Gidley's name *simus* is the earlier, it is the valid name for the subspecies.

COMPARISON OF RECENT MATERIAL

The living populations from Texas and Wisconsin differ in a number of characters from those of Idaho and Oregon. The most obvious difference is in the massiveness of the skull and mandibles of *Procyon lotor simus*, as pointed out by Nelson and Goldman (1930), in their original descriptions of the subspecies. We have analyzed in detail only those characters which may

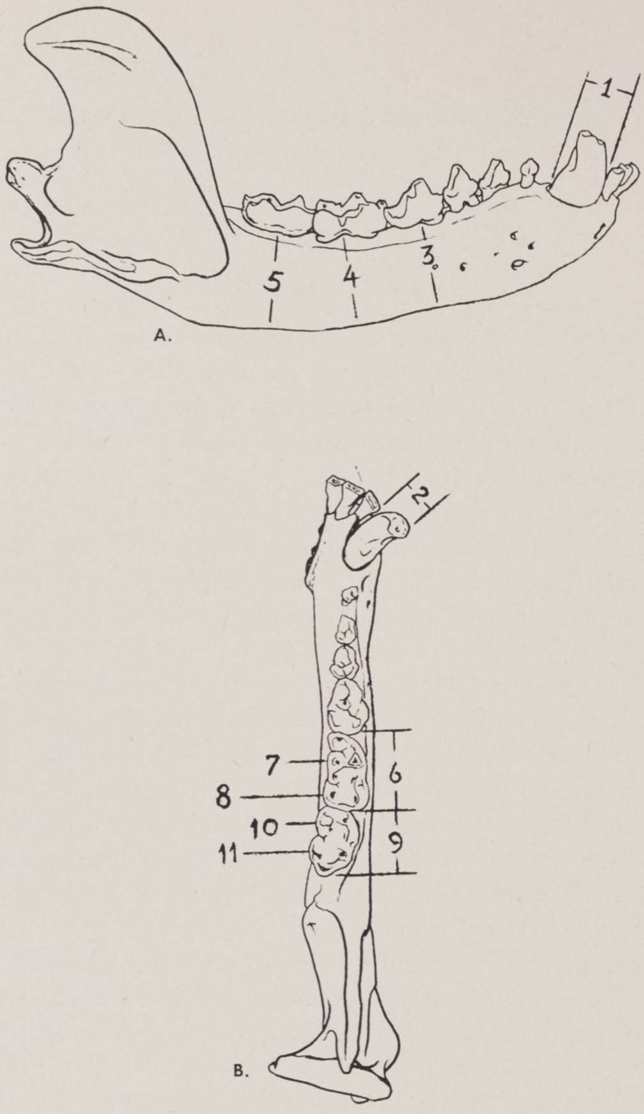

Fig. 1. Lateral (A) and occlusal (B) views of mandible of *Procyon lotor* showing measurements taken; 1) length of lower canine; 2) width of lower canine; 3) ramus depth @ P_4; 4) ramus depth @ M_1; 5) ramus depth @ M_2; 6) length of M_1; 7) anterior width of M_1; 8) posterior width of M_1; 9) length of M_2; 10) anterior width of M_2; 11) posterior width of M_2.

be compared with the fossil material. Measurements taken are illustrated in Fig. 1.*

The average depth of the mandible directly beneath P_4, M_1, and M_2 is much greater in the sample of *Procyon lotor simus* than in either *Procyon lotor fuscipes* or *Procyon lotor hirtus,* with the latter being intermediate (Tables 1, 2, 3). Frequency histograms of these characters in *P. l. simus*

* Drawings by Hal M. Story.

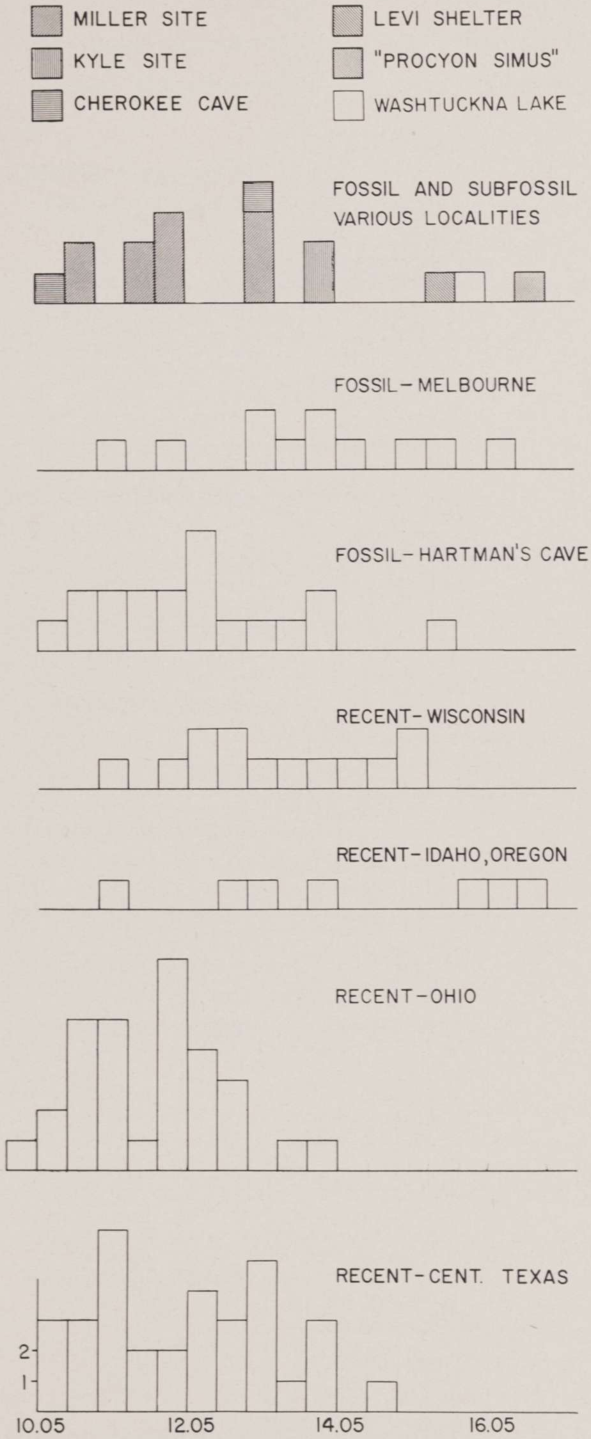

Fig. 2. Frequency histograms of depth of mandibular ramus below P_4 of fossil and Recent specimens of *Procyon lotor*.

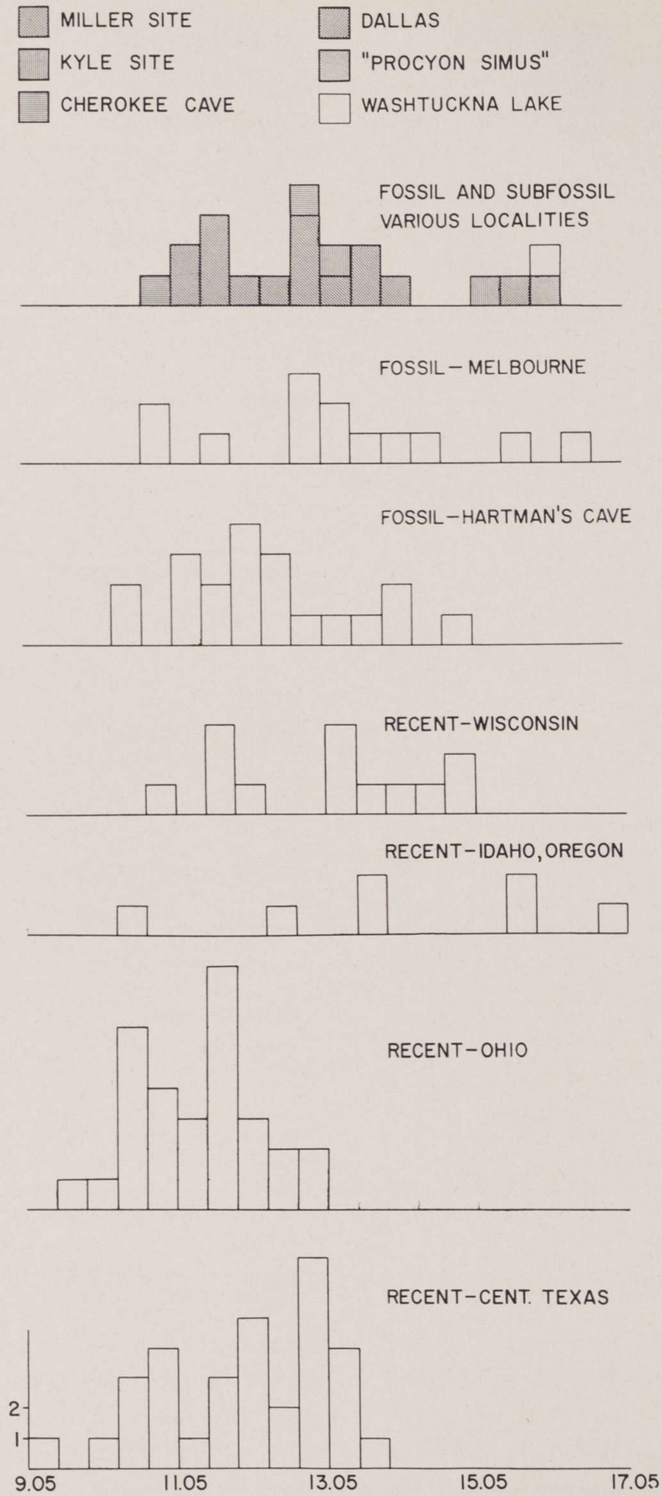

Fig. 3. Frequency histograms of depth of mandibular ramus below M_1 of fossil and Recent specimens of *Procyon lotor*.

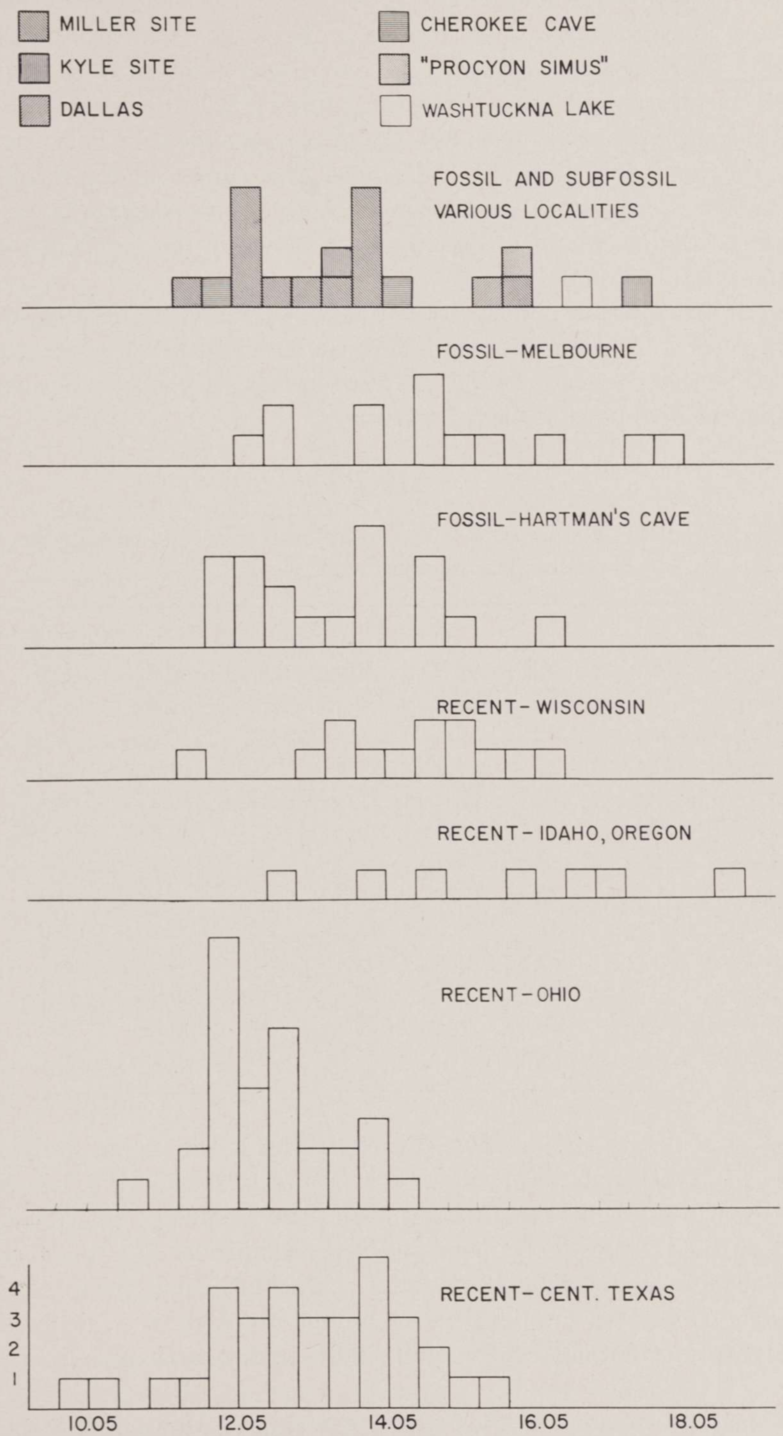

Fig. 4. Frequency histograms of depth of mandibular ramus below M_2 of fossil and Recent specimens of *Procyon lotor*.

show a definite bimodality (Figs. 2, 3, 4). The two females have slender mandibles and fall into the smaller size group, while the males, with one exception, have massive mandibles and form the larger size group. The male (USNM* 213130) which falls into the female group has unworn teeth, while teeth of the other males are quite worn, implying that the massive mandibles are acquired by the males with age. All of the specimens of *P. l. fuscipes* fall within the small size group of *P. l. simus*. The sample of the former is not sexed so that the extent of sexual dimorphism in this character is not known. However, a slight amount of bimodality is shown in the depth of the ramus at P_4 and at M_2.

There is an apparent bimodality in the depth of the ramus beneath M_1 for the sample of *P. l. hirtus*. Known males are included in both size groups. It may well be that the males in the small size group are young males which did not attain the heavy mandibles of maturity.

TABLE 1

Statistical data on teeth and mandibles of a Recent sample of *Procyon lotor fuscipes* from Central Texas

	N	Mean	Stan. Dev.	Coef. Var.	Obs. Range
Skull length	30	102.5 ± .71	3.9	3.8%	93.0 — 109.6
Skull width	33	50.11 ± .40	2.3	4.5%	46.5 — 54.0
Length Lower Canine	32	6.3 ± .12	.67	10.6%	5.0 — 7.5
Width Lower Canine	32	4.3 ± .09	.49	11.5%	3.4 — 5.7
Ramus Depth @ P_4	32	12.0 ± .21	1.2	10.1%	10.2 — 14.5
Ramus Depth @ M_1	32	11.9 ± .19	1.1	9.5%	10.1 — 13.8
Ramus Depth @ M_2	33	13.0 ± .22	1.3	10.1%	9.8 — 15.6
Length M_1	31	10.0 ± .07	.41	4.0%	9.3 — 11.1
Anterior Width M_1	31	6.2 ± .095	.53	8.6%	5.3 — 6.8
Posterior Width M_1	31	6.6 ± .08	.46	7.0%	5.7 — 7.6
Length M_2	29	9.7 ± .12	.67	6.9%	8.5 — 10.9
Anterior Width M_2	29	5.8 ± .07	.36	6.2%	5.0 — 6.8
Posterior Width M_2	29	5.7 ± .065	.35	6.1%	5.1 — 6.6

The sizes of the upper and lower canines differ in the recent samples. The canines of *P. l. simus* are larger than those of *P. l. hirtus* and *P. l. fuscipes* and show a greatly marked sexual dimorphism. The frequency distribution and the scatter diagrams of the dimensions of the canines of *P. l. hirtus* and *P. l. fuscipes* show no appreciable bimodality (Figs. 5, 6). In addition, the known males of the *P. l. hirtus* sample possess canines which show a fairly wide size range, indicating that there is no appreciable sexual dimorphism.

* Abbreviations used are: USNM, United States National Museum; BEG, Bureau of Economic Geology; SMUMP, Southern Methodist University Museum of Paleontology.

TABLE 2

Statistical data on teeth and mandibles of a Recent sample of *Procyon lotor hirtus* from Wisconsin

	N	Mean	Stan. Dev.	Coef. Var.	Obs. Range
Skull length	9	108.9 ± 2.3	6.8	6.2%	102.1 – 123.7
Skull width	10	54.4 ± 1.72	3.7	6.9%	48.7 – 61.2
Length Lower Canine	11	6.8 ± .24	.8	12.4%	5.0 – 8.3
Width Lower Canine	11	4.6 ± .09	.3	7.8%	3.8 – 5.0
Ramus Depth @ P_4	13	13.2 ± .36	1.3	10.0%	11.0 – 15.1
Ramus Depth @ M_1	13	13.0 ± .36	1.3	10.2%	10.9 – 14.8
Ramus Depth @ M_2	13	14.3 ± .36	1.3	8.8%	11.6 – 16.2
Length M_1	12	9.9 ± .14	.48	4.0%	9.0 – 10.5
Anterior Width M_1	12	6.1 ± .08	.28	4.6%	5.5 – 6.6
Posterior Width M_1	12	6.4 ± .12	.44	7.0%	5.8 – 7.0
Length M_2	11	10.1 ± .17	.57	5.6%	9.2 – 10.6
Anterior Width M_2	12	6.0 ± .16	.55	9.3%	5.3 – 7.4
Posterior Width M_2	12	5.7 ± .12	.43	7.5%	4.9 – 6.2

TABLE 3

Statistical data on teeth and mandibles of a Recent sample of *Procyon lotor simus* from Idaho and Oregon

	N	Mean	Stan. Dev.	Coef. Var.	Obs. Range
Skull length	7	110.5 ± 1.4	3.8	3.4%	103.0 – 114.5
Skull width	7	56.8 ± 1.09	2.9	5.2%	53.6 – 61.5
Length Lower Canine	7	7.50 ± .32	.83	11.1%	6.4 – 8.5
Width Lower Canine	7	5.70 ± .24	.63	11.0%	4.7 – 6.3
Ramus Depth @ P_4	7	14.2 ± .08	2.2	15.6%	11.0 – 16.8
Ramus Depth @ M_1	7	14.1 ± .08	2.3	16.2%	10.3 – 17.0
Ramus Depth @ M_2	7	15.6 ± .07	2.0	12.9%	12.8 – 18.5
Length M_1	7	10.3 ± .18	.49	4.8%	9.7 – 10.9
Anterior Width M_1	7	6.4 ± .106	.28	4.3%	6.0 – 6.8
Posterior Width M_1	7	7.0 ± .20	.54	7.7%	6.5 – 8.1
Length M_2	7	10.2 ± .16	.42	4.2%	9.7 – 10.6
Anterior Width M_2	7	6.3 ± .09	.24	3.8%	5.9 – 6.7
Posterior Width M_2	7	5.8 ± .05	.15	2.6%	5.6 – 6.1
Length Upper Canine	7	7.23 ± .30	.81	11.2%	6.0 – 8.4
Width Upper Canine	7	5.60 ± .27	.73	12.9%	4.5 – 6.4

The coefficients of variation of the canines in all the samples are somewhat higher than one would expect in mammals (Simpson, Roe, and Lowontin, 1960, p. 91). This may be due to some sexual dimorphism which is not sufficient to show up on the histograms. The coefficients of variation (V) for the

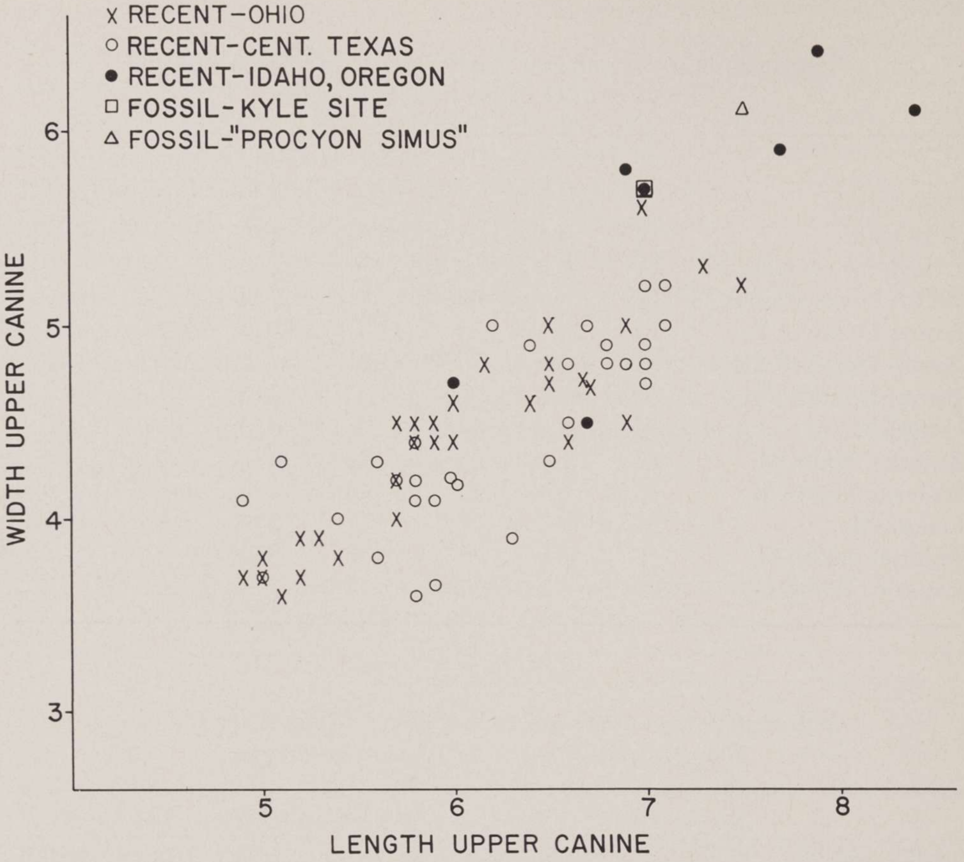

Fig. 5. Scatter diagram of length vs. width of upper canine of fossil and Recent specimens of *Procyon lotor*.

mandibular depths are also high. These measurements are clearly affected by both sex and age in the sample from Idaho and Oregon. This may also be true to a limited extent for the Wisconsin and Texas samples which would tend to give high values of V.

The occasional low values of V are probably chance variations resulting from sampling errors. This is supported by the fact that most of them occur in the small samples which are subject to such chance effects.

The I^3 of *P. l. simus* project laterally to the extent that they abrade prominent notches on the antero-internal surface of the lower canines. These notches may extend as much as twenty per cent of the way through the tooth and may be partly responsible for the high incidence of broken canines in this subspecies. All of the specimens of this subspecies which were studied either exhibited these notches or else had the canines broken off where the notch occurred. There is no doubt that the breakage took place while the animal was still alive, as all of the broken canines have been rounded by subsequent wear. These notches were seen on only seven of the thirty-seven

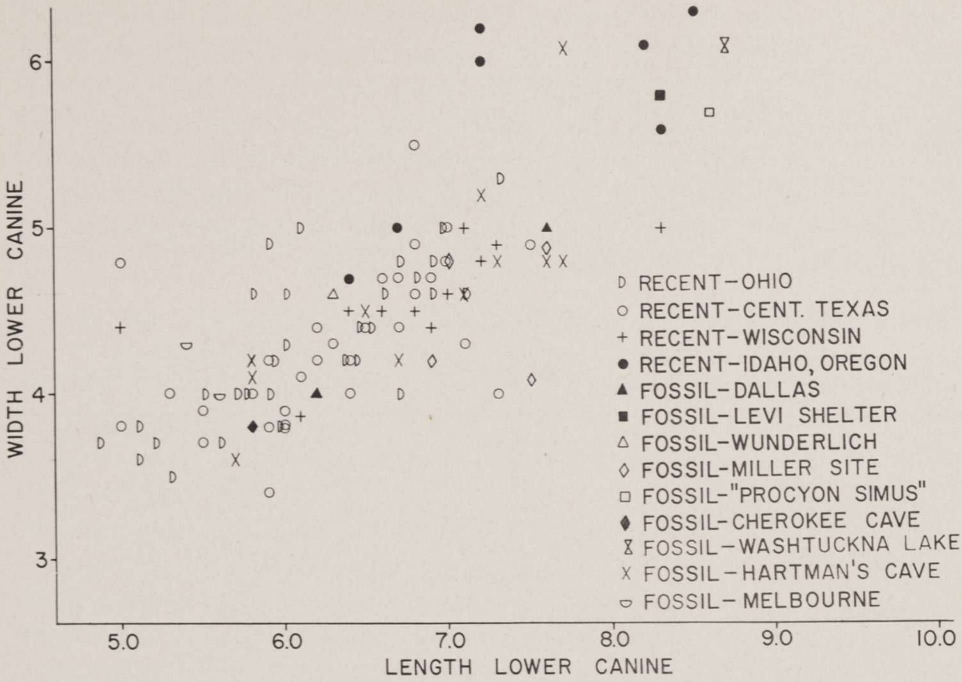

Fig. 6. Scatter diagram of length vs. width of lower canine of fossil and Recent specimens of *Procyon lotor*.

specimens of *P. l. fuscipes* and in none of the thirteen specimens of *P. l. hirtus*. All of the notches seen in *P. l. fuscipes* were quite small and shallow in comparison to those of *P. l. simus*.

The incisors, canines, and anterior premolars of *P. l. simus* are usually broken or badly worn. Although a considerable part of the breakage of the lower canines must be due to the weakening effect of the notching, it is evident that the anterior teeth in the mouth were subjected to very severe wear. The exact cause of this wear is not known, but it seems reasonable to attribute it to a difference in diet between the subspecies. This condition is rarely seen in specimens of *P. l. fuscipes* or *P. l. hirtus*.

The sample of *P. l. simus* differs from the other two samples studied in the absence of a small anterior cingular cuspule on M_1.

The specimens of *P. l. simus* also exhibit a much greater width of the suborbital portion of the molar. The least width of the *P. l. simus* is 10.3 mm., with the others considerably larger, while the greatest width in the *P. l. fuscipes* is only 10.5 mm.

A Recent sample of 30 skulls and mandibles is available from Ashtabula in northeastern Ohio. The sample is very similar to other Recent samples from eastern North America in the size of the canines, development of the anterior cingular cusp on M^1 and the lack of any facets on the antero-internal angle of the lower canine. The sample shows somewhat shallower mandibles than most of the other Recent samples. Examination of the teeth shows that almost all of the individuals had just acquired their permanent teeth at the time of death and are young adults. The depth of the jaw in the Recent samples from Idaho-Oregon has been shown to be in part a function of age and the same is probably true for other populations. Thus the low value for the depth of the mandible of the Ohio sample may be caused by the biased age distribution of the sample. The low values of the coefficients of variation of this character (Table 4) may be caused by this factor.

TABLE 4

Statistical data on teeth and mandibles of a *Procyon lotor* from Ashtabula, Ohio

	N	Mean	Stan. Dev.	Coef. Var.	Obs. Range
Length Lower Canine	30	6.04 ± .13	.7267	12.02	4.9 – 7.3
Width Lower Canine	30	4.44 ± .09	.5203	11.73	3.5 – 5.2
Length P_4	30	7.19 ± .07	.3868	5.38	6.4 – 7.8
Width P_4	30	5.12 ± .05	.3075	6.01	4.4 – 5.7
Length M_1	30	9.85 ± .10	.5576	5.66	8.2 – 10.8
Anterior Width M_1	30	5.91 ± .07	.4183	7.07	5.0 – 6.9
Posterior Width M_1	30	6.49 ± .08	.4566	7.04	5.5 – 7.5
Length M_2	30	9.70 ± .09	.5308	5.47	8.7 – 10.7
Anterior Width M_2	30	5.78 ± .06	.3295	5.70	5.0 – 6.5
Posterior Width M_2	30	5.52 ± .05	.3104	5.62	5.0 – 6.1
Ramus Depth @ P_4	30	11.60 ± .17	.9629	8.30	10.0 – 13.7
Ramus Depth @ M_1	30	11.29 ± .15	.8523	7.55	10.3 – 12.9
Ramus Depth @ M_2	30	12.47 ± .15	.8578	6.88	10.5 – 14.3
Length Upper Canine	30	6.12 ± .12	.6557	10.71	4.9 – 7.5
Width Upper Canine	30	4.28 ± .08	.4817	11.25	3.6 – 5.6

COMPARISON OF FOSSIL AND SUB-FOSSIL MATERIAL

Levi Shelter: The raccoon material from the Levi Shelter consists of the anterior portion of the left lower mandible (BEG 40449–39). The ramus is quite deep beneath the pre-molars and the large canine is broken (Fig. 7). In all of these characters it agrees with the older males of *P. l. simus*. The specimen is from Zone 2, twelve to eighteen inches below the surface, and was associated with charcoal which has been dated at 7338 ± 160 years B. C. (Alexander, personal communication).

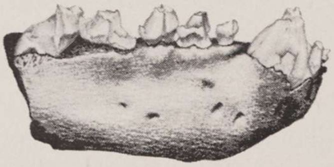

Fig. 7. Labial view of mandible of *Procyon lotor simus* from Levi Shelter (BEG 40449–39).

Wunderlich Site: The material from this site consists of the anterior portion of a right mandible with the canine and a remnant of P_4, (BEG 40451–3), and a right maxilla with P^4 and M^2 present (BEG 40451–2). The mandibular fragment is too badly broken to obtain exact measurements of the ramus beneath P^4 and the molars, but it is obviously quite deep and compares favorably with *P. l. simus* and the material from the Levi shelter. The canine is too badly broken to be measured. The M^1 is missing from the maxilla so that it is not possible to determine whether the anterior cingular cusp is present.

Kyle Site: The material from this site consists of a left mandible with P_4 and M_1 (BEG 40534–1); the following parts of a shattered skull: right maxilla with I^{2-3}, canine and P^2, left maxilla with I^3, canine and P^{1-2}, part of a right molar and fragments of the brain case (BEG 40534–2); a left mandible with no teeth (BEG 40534–3); part of a right mandible with P_4 and M_2 (BEG 40534–4); and a fragment of a left mandible with no teeth (BEG 40534–5). One specimen (BEG 40534–1) may be grouped with the older males of *P. l. simus* on the basis of the mandible, while the other, (BEG 40534–4), falls into the group containing the females of *P. l. simus* and the *P. l. fuscipes* sample (Figs. 2, 3, 4, 5). These specimens probably represent a male and female from a population which shows sexual dimorphism similar to that of *P. l. simus*. The material is from Zones 2, 3, and 4 (Jelks, 1962). Charcoal from Zone 2 has been dated at A.D. 561 ± 150 years, while that from Zone 4 has been dated at A.D. 129 ± 150 years, (Jelks, 1962:97).

The associated fauna which has been tabulated by Lundelius, (*In* Jelks, 1962, Appendix) contains only one species, *Pitymys pinetorum*, not found in the area today. Its present range in Texas is confined to the northeastern portion of the state with a small relict population existing in Kerr County (Blair, 1958). Its presence in the deposit probably indicates more moist conditions at the time of the deposit than exist in the area today.

Cave Bear Cave, California: *Procyon simus* was described and named by Gidley in 1906, on the basis of a skull and mandibles from Cave Bear Cave near the McCloud River in northern California. The measurements of the mandibles and canines are very similar to those of the Recent sample of *Procyon lotor* from Idaho and Oregon. Gidley's figure shows no evidence of the cingular cusp on the anterior edge of M^1. We feel sure that this specimen is referable to the living population named *P. l. excelsus* by Nelson and Goldman (1930). There seem to be no characters whatsoever to justify its separation as a distinct species of *Procyon*.

Manton Miller Site: A good sample of raccoon mandibles and maxillae is available from this site (Table 5). This material is similar in every respect to the living population in Texas. It differs from the sample of *P. l. simus* and from the sub-fossil material in the same ways that *P. l. fuscipes* does (Figs. 2–6). According to Jelks (personal communication), the human and cultural material associated with the raccoon material indicates an age between eight

TABLE 5

Statistical data on teeth and mandibles of a sample of *Procyon lotor* from the Manton Miller Site

	N	Mean	Stan. Dev.	Col. Var.	Obs. Range
Length Lower Canine	3	7.2	.310	4.30	6.9 – 7.6
Length M_1	6	10.2	.332	3.25	9.6 – 11.0
Length M_2	4	10.0	.341	3.41	9.1 – 10.6
Ramus Depth @ P_4	10	11.8	.882	7.46	10.6 – 13.2
Ramus Depth @ M_1	12	12.3	.765	6.21	11.1 – 13.7
Ramus Depth @ M_2	12	13.1	1.14	8.70	11.5 – 15.8

and twelve hundred years A.D. As far as is known, there are no animals present in the fossil material that are not present in Delta County today.

Whelan Site: The raccoon material from this site consists of a left mandible with a complete dentition (BEG 40457–1). Modern in every respect (Table 6), its age is approximately A.D. 1000 (Jelks, personal communication).

TABLE 6

Measurements of teeth and mandibles of fossil and subfossil raccoons

	Length Lower Canine	Width Lower Canine	Length M_1	Length M_2	Ramus Depth @ P_4	Ramus Depth @ M_1	Ramus Depth @ M_2
Kyle Site							
BEG 40534–4	----	----	----	----	13.8	13.2	13.3
BEG 40534–1	----	----	11.0	----	14.0	15.2	17.4
Wunderlich Site							
BEG 40451–3	6.3	4.6	----	----	----	----	----
Levi Shelter							
BEG 40449–39	8.3	5.8	----	----	15.4	----	----
Cave Bear Cave type of *Procyon simus*							
USNM	8.0(8.6)	(5.7)	10.1	9.1	6.4	16.0	16.0
Cherokee Cave							
AMNH 45734	5.8(alv)	3.8	9.4	9.2	13.1	12.8	----
AMNH 45735	----	----	9.5	----	10.3	10.8	11.7
Dallas Area							
SMPMP 498	6.2	4.0	----	----	----	----	----
SMPMP 4123	----	----	----	----	12.1	----	----
510H	7.6	5.0	----	----	15.7	15.6	15.6
Whelan Site							
BEG 40457–1	7.5	----	10.3	10.1	13.5	13.9	13.8
Buzzard Cave							
BEG 40458–1	----	----	----	----	13.7	13.6	----

Buzzard Cave: The material from this cave consists of a left mandible with P_2 (BEG 40458–1). It shows no differences from the extant Texas forms (Table 6). Its age is approximately A.D. 1000–1600 (Jelks, personal communication).

Dallas: Two mandibles from the T-2 terrace (SMUMP 60202 and SMUMP 60167) at Dallas and one from its equivalent on Hickory Creek (SMUMP 60735), in Denton County make up this material (Slaughter, personal communication). These are tentatively dated as of Sangamon age. These mandibles are somewhat deeper and heavier than the Central Texas *P. l. fuscipes* but are not nearly so massive as *P. l. simus* (Figs. 3, 4). The canines are similar to those of *P. l. fuscipes*. In these characters this material resembles the specimens of *P. l. hirtus* from Wisconsin.

Conard Fissure: Brown (1909) figures a right mandible of a raccoon from the Conard Fissure in Arkansas. The figure indicates that the mandible is like that of a living form in its depth and the size of the canine.

Cherokee Cave, St. Louis: *Procyon* material associated with a late Pleistocene fauna have been reported by Simpson (1949) from this cave. The depths of the mandibles and the length and width of the canine alveolus of one are shown in Table 6 and Figs. 2, 3, 4, 6. They fall with the samples of the living populations from Texas and Wisconsin. The skull also is similar to the living forms from Texas and Wisconsin in its size and robustness.

Washtuckna Lake, Washington: The raccoon material available from this locality consists of one right mandible. The depth of the mandible and the size of the canine, as estimated from the size of the alveolus, indicates that this specimen is referable to *Procyon lotor simus*.

Melbourne, Florida: This sample is very similar to that from Hartman's Cave but contains two individuals with depth of mandibles in the range of *Procyon lotor simus*. Only three lower and one upper canine were available. None falls into the *P. l. simus* group and none shows any sign of the antero-internal notch.

The few M^1's which are available are more square than in *P. l. simus* and all have the anterior cingular cusp which is absent in *P. l. simus* (Table 7).

Although the Melbourne fauna may not be completely homogeneous it is probably all late Pleistocene in age (Gazin, 1950).

Hartman's Cave, Pennsylvania: A sample of 22 left mandibles and maxillae is available from this site (Table 8). This sample is most like the Recent one from Wisconsin. The depth of the mandibles shows very similar distribution and except for one large specimen the sizes of the canines are alike. The lower canines do not show the notch on the antero-internal side.

Leidy (1889) described the fauna from this cave. It is probably Wisconsin in age.

DISCUSSION

Archeological sites along the Balcones Escarpment from Hill County to

TABLE 7

Statistical data on teeth and mandibles of a sample of *Procyon lotor* from the Pleistocene of Melbourne, Florida

	N	Mean	Stan. Dev.	Coef. Var.	Obs. Range
Lower length canine	3	6.2	----	----	5.4 — 7.6
Width lower canine	3	4.4	----	----	4.0 — 5.0
Length P_4	7	7.2 ± .24	.63	8.7%	6.9 — 7.6
Width P_4	8	5.0 ± .16	.44	8.7%	4.9 — 5.3
Length M_1	6	9.7	----	----	9.2 — 9.8
Anterior Width M_1	6	5.9	----	----	5.3 — 6.4
Posterior Width M_1	6	6.2	----	----	5.8 — 6.8
Length M_2	10	9.7 ± .27	.86	8.8%	8.1 — 10.4
Anterior Width M_2	10	5.7 ± .06	.20	3.5%	5.4 — 6.0
Posterior Width M_2	10	5.4 ± .08	.27	5.0%	4.9 — 5.9
Ramus Depth P_4	11	13.7 ± .48	1.60	11.7%	10.9 — 16.4
Ramus Depth M_1	13	13.3 ± .43	1.55	11.7%	10.8 — 16.4
Ramus Depth M_2	13	14.7 ± .43	1.55	10.5%	12.4 — 17.7

Comal County have yielded raccoon material closely resembling the living populations from Idaho and Oregon. The time represented by the deposits in these sites ranges from 7338 years B.C. to A.D. 1300. The presence of this material indicates a much wider distribution of massively built raccoons in the past. They were probably distributed throughout the Rocky Mountains during the Pleistocene although the only fossil record at present is the occur-

TABLE 8

Statistical data on teeth and mandibles of a sample of *Procyon lotor* from Pleistocene deposits of Hartman's Cave, Pennsylvania

	N	Mean ± 1 S.E.	Stan. Dev.	Coef. Var.	Obs. Range
Length lower canine	11	6.8 ± .23	.78	11.4%	6.5 — 7.7
Width lower canine	11	4.6 ± .20	.67	14.5%	3.6 — 6.1
Length P_4	9	7.0 ± .06	.20	2.8%	6.8 — 7.5
Width P_4	9	5.1 ± .06	.18	3.8%	4.9 — 5.5
Length M_1	6	9.5	----	----	9.1 — 9.8
Anterior Width M_1	6	5.7	----	----	5.1 — 5.9
Posterior Width M_1	6	6.3	----	----	5.9 — 6.9
Length M_2	4	9.6	----	----	9.2 — 10.0
Anterior Width M_2	4	5.7	----	----	5.3 — 6.0
Posterior Width M_2	4	5.4	----	----	5.2 — 5.7
Ramus Depth P_4	19	12.2 ± .29	1.3	10.8%	10.3 — 15.3
Ramus Depth M_1	22	12.2 ± .25	1.3	10.4%	10.3 — 15.0
Ramus Depth M_2	19	13.4 ± .33	1.4	10.4%	11.9 — 16.4

rence from Cave Bear Cave in northern California. The radiocarbon dates indicate a late disappearance of this Pleistocene element from the Edwards Plateau.

The presence of the large, heavily built raccoons in Hill County during the same time interval as a modern type population in Delta County (A.D. 500 to 1000) raises some interesting questions concerning the geographic variation of raccoons in Texas in the past. If the material is correctly dated, raccoons must have shown more morphological variation across Texas at that time than at present. Whether this was the situation through a considerable period of time or whether it represents a stage in the westward movement of the modern type of raccoon is not known. The Dallas and Hickory Creek specimens do not offer much help in answering this question. As already noted, they seem to be somewhat larger than the Recent form, but the sample is much too small for a reliable comparison of the two types.

Pleistocene raccoons from eastern North America have not been studied in detail, although material is not uncommon. There is material from fissure fills in the lead district of Illinois upon which LeConte (1848) based a separate species, *Procyon priscus*. Examination of the type shows that it is within the size range of *Procyon lotor* in the depth of the mandible and the size of the canine. There are no other distinguishing characters and it is here considered a synonym of *Procyon lotor*.

The remains of raccoons from the Seminole Field, Florida, reported by Simpson (1929) resemble the Recent form but the material is inadequate for detailed comparisons.

The material from Cherokee Cave in St. Louis (Simpson 1949) is modern in every respect (Fig. 3) and the mandible from the Conard Fissure in Arkansas figured by Brown (1909) appears to be referable to the small Recent form.

There are two other samples of Pleistocene raccoons, from Hartman's Cave, Pennsylvania, and Melbourne, Florida, which give a much better idea of the range of variation than the ones just mentioned. These samples show that the Pleistocene raccoons in these areas had somewhat heavier mandibles than the Recent Central Texas and Ohio forms, but not as massive as in *P. l. simus*. Except for one individual from Hartman's Cave, the Pleistocene forms from the eastern United States do not have the large canines of *P. l. simus*. No samples of Recent raccoons from Florida or Pleistocene raccoons from Wisconsin are available so no comparison can be made between Pleistocene and Recent forms in those areas. A comparison of the Hartman's Cave sample and the Recent Ohio sample shows that the latter is somewhat smaller in the depth of the mandible and does not have large canines. Any conclusion that this reflects differences in the Pleistocene and Recent populations in the Ohio-Pennsylvania region should be taken as only tentative. The two localities are 300 miles apart and as pointed out above, the Recent Ohio sample is probably biased in favor of young adult individuals.

From the evidence available two geographic variants can be recognized in the late Pleistocene raccoons. The eastern type is very similar to or only slightly larger than the living type in this area. The western type is similar to the living *Procyon lotor simus* of Idaho and Oregon. The geographic position and the nature of the zone of contact between these types is unknown.

The details of the method of replacement of the *P. l. simus* type by the modern type are not known. Whether there was extensive hybridization or not, little of the *P. l. simus* type could be discerned in Recent specimens examined by the authors. The only character which could be interpreted as a heritage of the *P. l. simus* population is the occasional small wear facet on the antero-internal angle of the lower canine in the Recent Central Texas sample.

The cause of the disappearance of the *P. l. simus* type of raccoon from the Balcones escarpment and its subsequent replacement by the modern type is probably to be found in the post-Pleistocene climatic changes. The presence in some of the deposits of *Pitymys pinetorum,* which now occurs only in more humid regions to the northeast, would indicate that a considerable change has taken place, most likely that of increasing aridity. The late date of its disappearance is not entirely unexpected in view of the many canyons which dissect the edge of the Edwards Plateau. These canyons are almost always more mesic than is the plateau itself. They would be expected to offer refuge to species which require humid conditions for survival. This expectation is confirmed by the existence along the Balcones Escarpment of relict populations of a number of species of both plants and animals whose main distribution is now to the north and east (Blair, 1958). *Procyon lotor simus* may well have existed in these areas as a relict population as late as A.D. 1300. Other isolated populations may have survived equally late and even into the present in similar refuge areas in the Rocky Mountains. It appears that the Recent fossil and sub-fossil *Procyon* complex is but another example of the replacement of a large Pleistocene form by a smaller recent one.

SUMMARY

Raccoon material from various localities in Central Texas resembles the living population of *P. l. simus* currently confined to Idaho, eastern Oregon, portions of Washington, and eastern British Columbia, and differs from the recent Central Texas population. The fossil material resembles the *P. l. simus* specimens in having deep, massive mandibles, larger, heavier canines, a wide suborbital ring, and notches in the lower canines. The age of the raccoons exhibiting these characters ranges from 7338 B.C. to about A.D. 1300 at the Kyle Site in Hill County. The youngest appear to be contemporaneous with modern type raccoons from the Miller Site in Delta County, thus implying a rapid morphological gradient across Texas at that time.

The Central Texas material indicates that the large, massively built raccoons now called *P. l. excelsus* and *Procyon simus* Gidley had a much wider

distribution during the Pleistocene, probably throughout the western half of North America. The disappearance of this type from the eastern portion of the Edwards Plateau occurred only recently. The climatic changes associated with the disappearance of the ice sheets is probably responsible for its disappearance. It is evident that this type of raccoon persisted along the edge of the Edwards Plateau in Texas until about A.D. 1200.

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